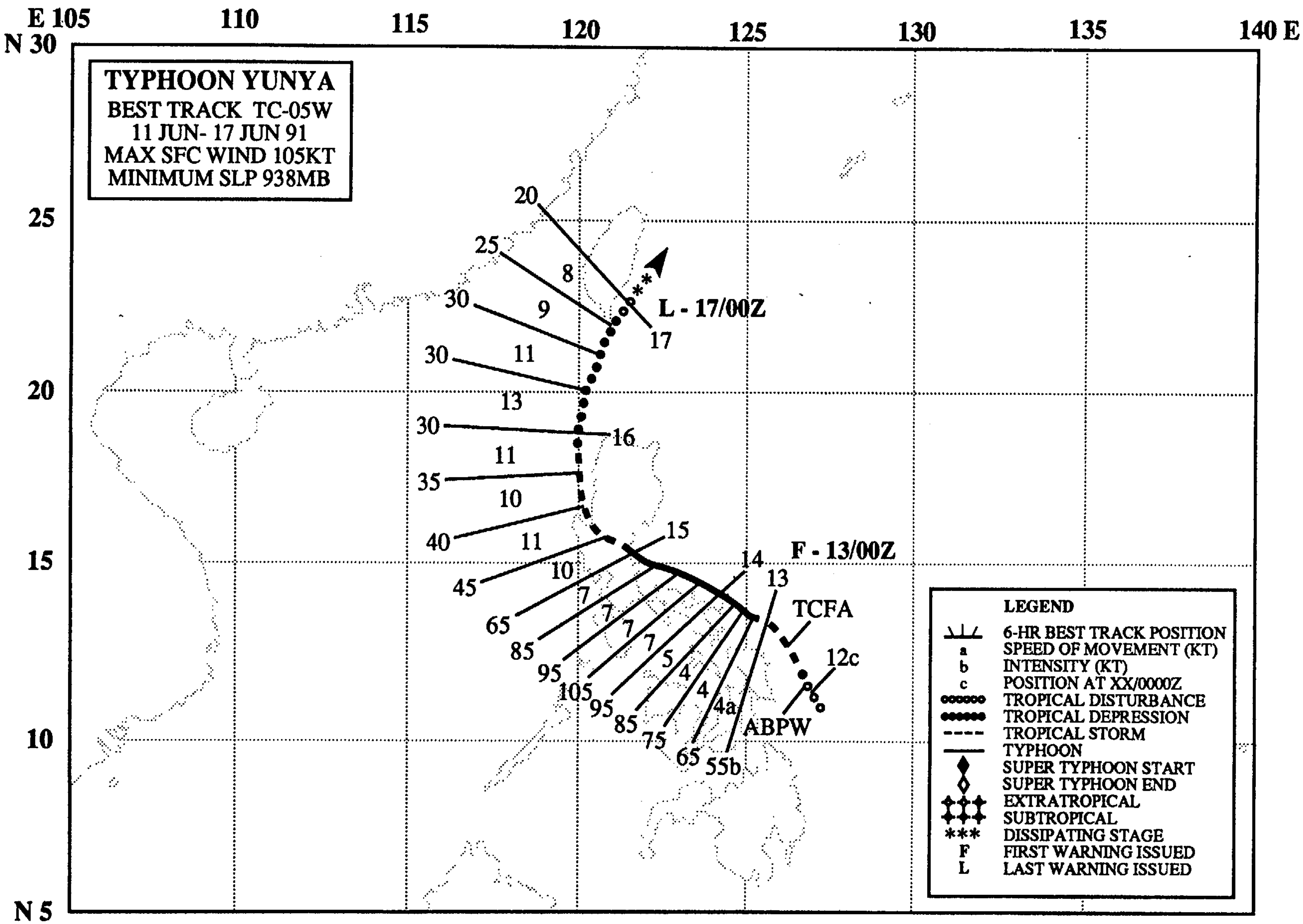

TYPHOON YUNYA
BEST TRACK TC-05W
11 JUN- 17 JUN 91
MAX SFC WIND 105KT
MINIMUM SLP 938MB
E 105
110
115
120
125
130
135
140 E
N 30
25
20
15
10
N 5
L - 17/00Z
F - 13/00Z
TCFA
ABPW
12c
55b
4a
LEGEND
6-HR BEST TRACK POSITION
a SPEED OF MOVEMENT (KT)
b INTENSITY (KT)
c POSITION AT XX/0000Z
TROPICAL DISTURBANCE
TROPICAL DEPRESSION
TROPICAL STORM
TYPHOON
SUPER TYPHOON START
SUPER TYPHOON END
EXTRATROPICAL
SUBTROPICAL
DISSIPATING STAGE
F FIRST WARNING ISSUED
L LAST WARNING ISSUED

TYPHOON YUNYA (05W)

I. HIGHLIGHTS

Typhoon Yunya, the first significant tropical cyclone of June, broke a nearly month-long lull in activity in the western North Pacific. Yunya was noteworthy because a ship transited through its center, providing a unique glimpse of the structure of a rapidly-developing midget typhoon. Its passage through central Luzon coincided with the massive eruption of Mount Pinatubo and subsequent evacuation of personnel from Clark AB.

II. TRACK AND INTENSITY

Yunya formed just east of Samar Island, Republic of the Philippines, in an area of low vertical wind shear associated with a col produced by a Tropical Upper Tropospheric Trough (TUTT). Unlike normal TUTT-induced tropical cyclone genesis which occurs in the region of strong upper-level divergence between the TUTT and the sub-equatorial ridge circulation to the southeast, Yunya's formation occurred southwest of the TUTT axis.

The broad disturbance which spawned Yunya was first discussed on the 110600Z Significant Tropical Weather Advisory. Between 111200Z and 121200Z, all surface reports within 100 nm (185 km) of the low-level circulation were less than 10 kt (5 m/sec). After a Tropical Cyclone Formation Alert was issued at 121500Z, the system began to rapidly develop. At 121730Z, a satellite analysis based on spiral band curvature estimated a maximum intensity of 30 kt (15 m/sec). Post analysis revealed a tiny central dense overcast (CDO) supporting 45 kt (23 m/sec). Then, at 121836Z the **USNS Spica** passed through the center of the system, and reported a central pressure of 989.5 mb with winds of 60 kt (30 m/sec). At 130000Z, JTWC issued its first warning on Yunya with an intensity of 45 kt (23 m/sec) was based on a conversion from observed minimum sea-level pressure to maximum sustained surface wind using the Atkinson-Holliday (1977) relationship. Post analysis determined the actual intensity was closer to 55 kt (28 m/sec).

Yunya reached minimal tropical storm intensity after existing for only 21 hours and minimal typhoon intensity in only 39 hours. In so doing, it did not exhibit the classic tropical cyclone development traits, but those of rapid initial development, small surface wind field, and peripheral surface pressure rises presumably associated with subsidence generated by a tiny annular outflow pattern aloft. These traits are found to be common with "midget typhoon" development. The fortuitous (for meteorologists) passage of the **USNS Spica** near the center of Yunya confirmed its midget size via the pressure trace shown in Figure 3-05-1. The wind observations reported by **Spica** indicate that the

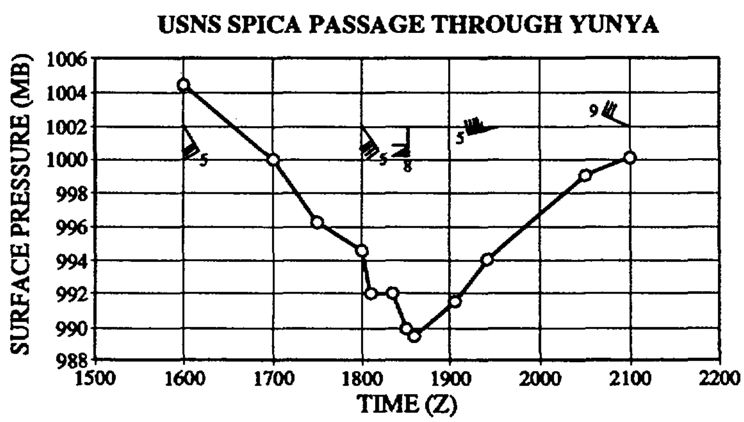

Figure 3-05-1. Time pressure cross-section reconstructed from data provided by the USNS Spica, which passed directly through the center of Yunya on the 12 of June.

area of winds greater than 30 kt (15 m/sec) was transited in a mere 5 hours. Since **Spica's** course and speed were reported as 286 degrees true at 16 kt (30 km/hr) for the duration of the transit, the associated 30 kt (15 m/sec) wind diameter for Yunya at this time was about 80 nm (150 km).

After moving northwestward for a day during its formation phase, Yunya then tracked west-northwestward toward central Luzon under the influence of the mid-level subtropical ridge. Yunya steadily intensified at a rate of 10 kt (5 m/sec) per 6 hours until 140600Z when it attained its peak intensity of 105 kt (55 m/sec) (Figure 3-05-2). Subsequently, strong north-northeasterly upper-level winds associated with an eastward building of the subtropical ridge circulation over Asia produced unfavorable vertical wind shear. As this shear (Figure 3-05-3) persisted, Yunya began to weaken even faster than it had intensified, having only minimal typhoon intensity as it made landfall just north of Dingalan Bay at 150000Z. Apparently, the midget size of the typhoon could not effectively buffer its core of convection from the shear. Yunya exited Luzon though the Lingayen Gulf as a weak tropical storm, and subsequently turned north toward a break in the subtropical ridge. The system continued to weaken due to strong vertical wind shear, grazing the southern tip of Taiwan as a tropical depression, and dissipating before it could complete full recurvature into the mid-latitude westerlies.

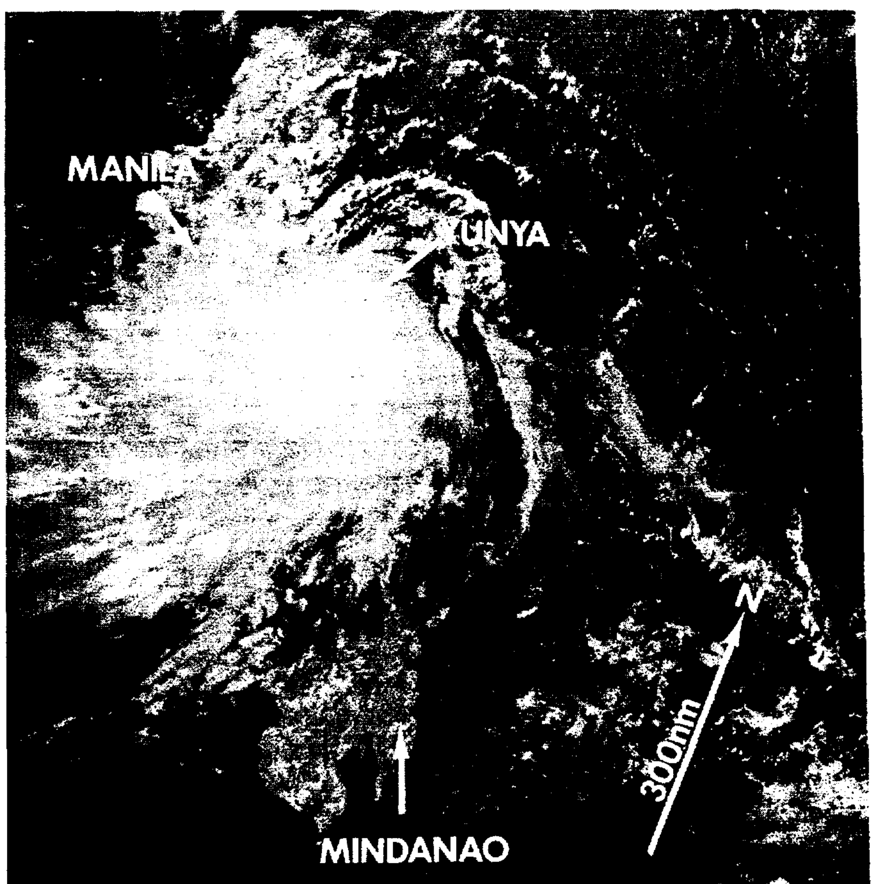

Figure 3-05-2. Yunya at peak intensity. Note the distortion of Yunya's cloud signature due to increasing upper-level north-northeasterly winds produced by a building subtropical ridge (140534Z June NOAA visual imagery).

III. FORECAST PERFORMANCE

The first two track forecasts issued by JTWC had Yunya moving in a northwestward direction toward a thin extension of the mid-level subtropical ridge, eventually grazing the northeast tip of Luzon (Figure 3-05-4). By the third warning however, JTWC correctly anticipated that Yunya's midget size

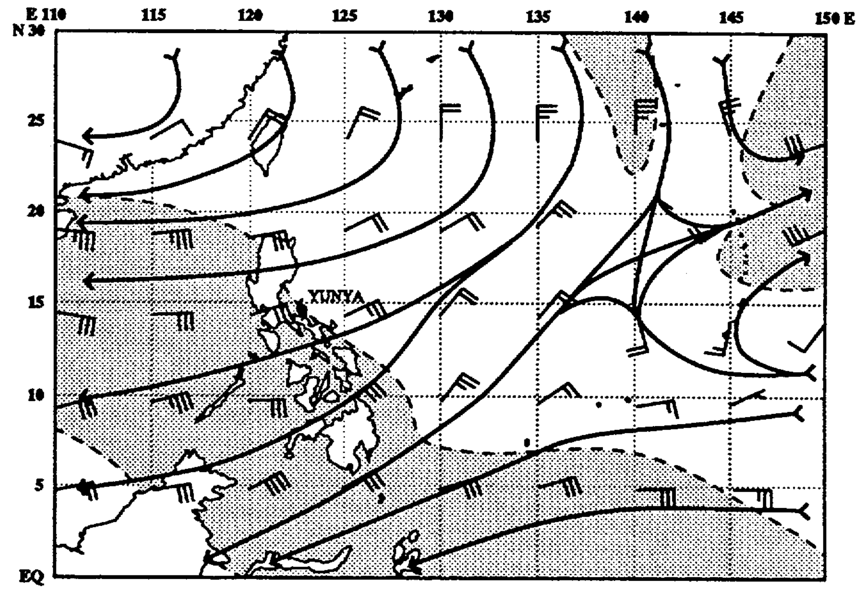

Figure 3-05-3. NOGAPS 200-mb analysis at 150000Z June showing an increased upper-level shear over Yunya. The JTWC hand-plotted/analyzed chart for this same this showed up to 40 kt (20 m/sec) 200-mb winds in the vicinity of Yunya. (Winds within the shaded area of the analysis are 30 kt (15 m/sec) or greater.)

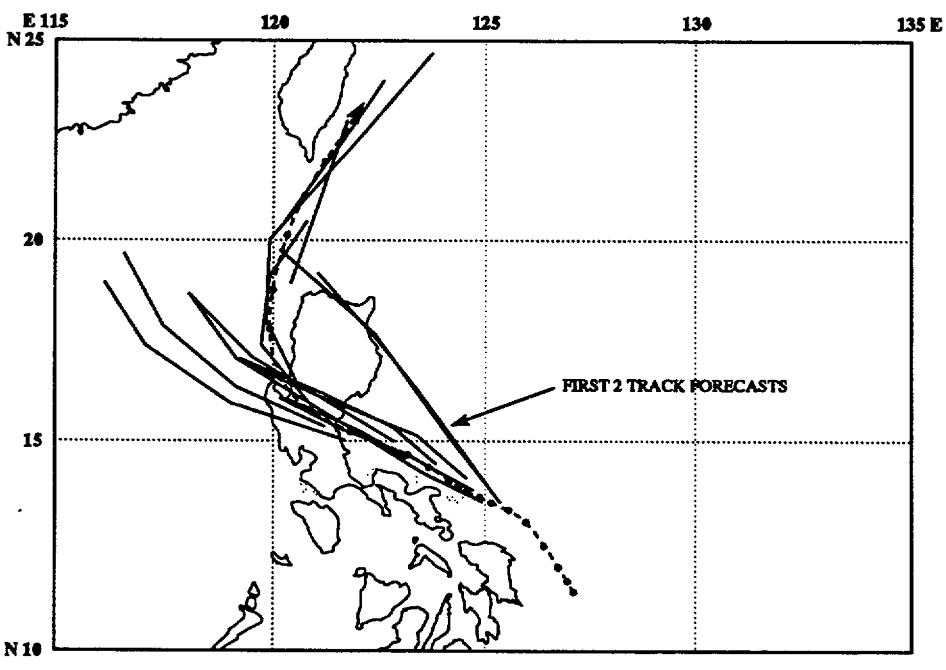

Figure 3-05-4. Graphic of all JTWC official forecasts issued for Yunya.

would prevent significant penetration into the thin ridge, and that Yunya would instead be steered around the periphery of the ridge, resulting in a track across central Luzon. After Yunya crossed Luzon, it turned toward the ridge axis sooner than anticipated, highlighting the sensitive and subtle interplay between tropical cyclone and weak ridge near the point of recurvature.

Figure 3-05-5 shows the objective forecast guidance that JTWC used to develop the 140000Z forecast, and Figure 3-05-6 shows the 48-hour NOGAPS 700-mb prognostic field associated with the mid-point of the 72-hour forecast period beginning at 140000Z. From these figures, it is evident that JTWC had to discount the track forecasts by the dynamical models NGPS and OTCM which tended to turn Yunya prematurely through the thin subtropical ridge. Forecasters placed more weight on climatology (CLIM), CSUM (statistical-dynamical) and FBAM (a steering-type dynamical aid) which provided better guidance, but which historically tend to be slow to forecast recurvature. It is interesting to note also that the Japanese Meteorological Agency Typhoon Model (JTYM) and the United Kingdom Meteorological Office Model (EGRR) also forecast Yunya through the thin ridge extension, suggesting that this problem is endemic to the current generation of vortex-tracking numerical models. With the midget typhoon, the model's inability to accurately describe the cyclone-ridge interaction may be a resolution problem.

Despite a slow speed bias, JTWC's forecasts of Yunya across Luzon provided key warning support which helped prompt DOD officials to evacuate the Clark and Subic areas in anticipation of the devastation to be caused by the Mount Pinatubo ash moistened and redirected by Yunya.

IV. IMPACT

Yunya made landfall in central Luzon near midday on 15 June, and the associated heavy rainfall caused flooding that washed away bridges and left one person dead. However, this direct impact of Yunya was relatively minimal compared to its subsequent influence on the massive cloud of ash produced by the eruption of Mount Pinatubo on the same day. As Yunya crossed central Luzon, its deep cyclonic circulation redistributed the ash, that normally would have been carried out over the South China Sea, over land. This greatly aggravated the impact of the water-laden ash fall-out on Clark AB and at the Subic Bay/Cubi Pt naval complex, resulting in the downing of power lines and the collapse of most flat-roofed buildings due to overloading.

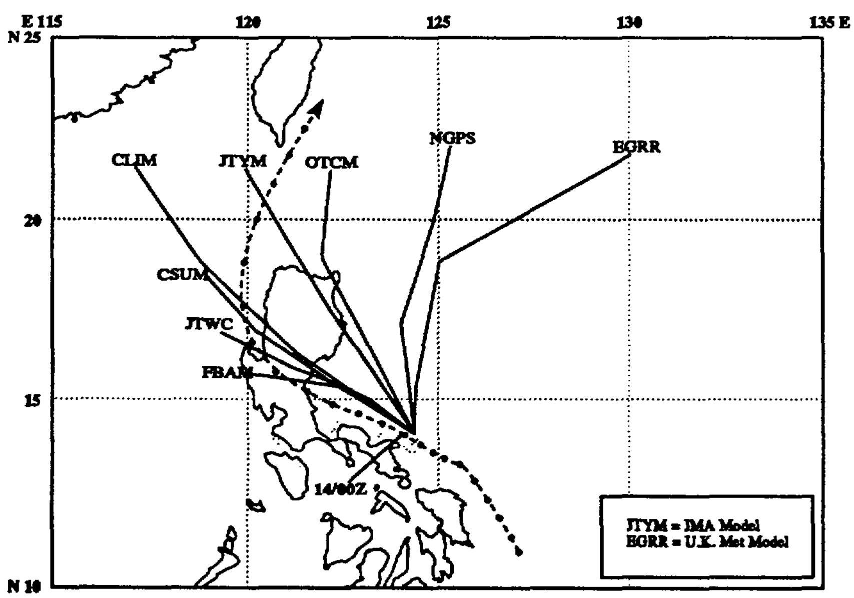

Figure 3-05-5. Graphic of JTWC official forecast and the associated objective forecast aids valid at 140000Z June.

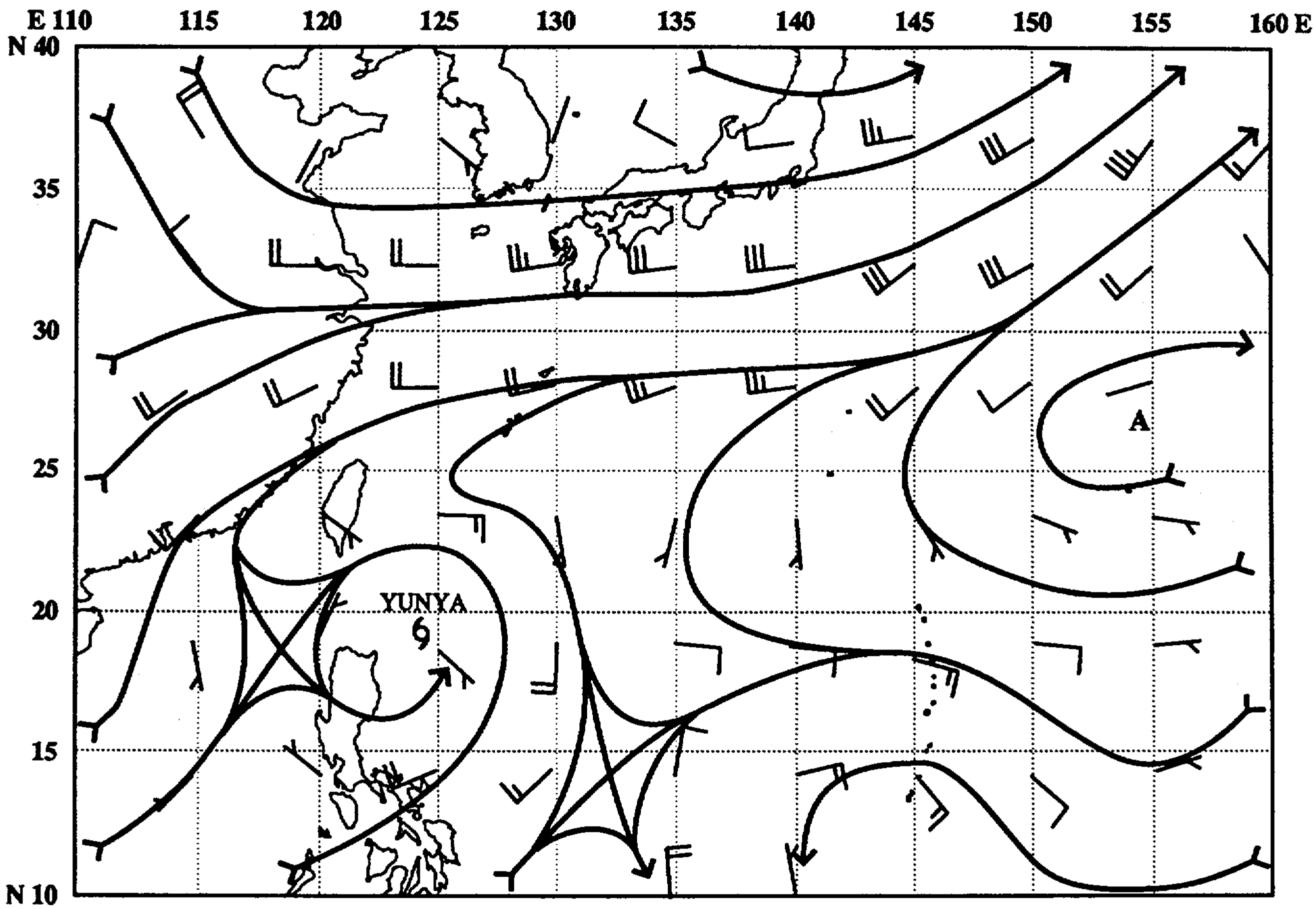

Figure 3-05-6. NOGAPS 700-mb 48-hour prognostic field valid at 151200Z, which is the midpoint of the forecast period beginning at 140000Z.